Department of
Veterans Affairs

Seismic Design Requirements

H-18-8

June 2002
Office of Facilities Management
Facilities Quality Office

FOREWORD

Background

In 1971, the San Fernando earthquake, when two VA buildings collapsed, VA was required to undertake a full seismic safety program. Title 38 - United States Code, section 8105 required the Secretary to assure that each medical facility constructed or altered shall be of construction that is resistant to fire, earthquake, and other natural disasters. This initiated the creation of the Advisory Committee on Structural Safety of VA Facilities, which formally approved the original VA Seismic Design document, H-08-8, Earthquake Resistant Design Requirements for VA Facilities in 1975. These requirements were developed with the concept that all VA Essential Facilities must remain operational after an earthquake.

The document is periodically updated and revised. The revision of H-08-8 to H-18-8 in 1995, was a major rewrite to bring VA seismic design requirements more in line with national model codes. The main thrust of H-18-8 was to adopt the Uniform Building Code (UBC) for the most part and to adopt the California Building Code, Title 24, for Essential Facilities in areas of high seismicity. The Advisory Committee on Structural Safety of VA Facilities approved that revision on December 5, 1995.

Current Revision:

Highlights are:

References to the UBC and Title 24 have been replaced by references to IBC 2000 and FEMA 356. FEMA 356 is to be used for the rehabilitation of existing buildings by permission from the Office of Facilities Management (FM).

Separate sections have been created for the requirements for design of new facilities, evaluation of existing facilities, and rehabilitation of existing facilities.

Specific requirements have been added within the use of IBC. Restrictions on diaphragm deflection for wall attachments, diaphragm aspect ratios, and concrete structures now specifically apply only to High and Very High seismicity.

Site data requirements have been added for new and existing facilities in Moderate High, High, and Very High seismicity. Engineering geologic and site-specific reports are required, but give the option to use the USGS maps, if allowed by IBC or FEMA 356.

A Seismicity Map showing the location of VA Medical Centers has been added at the end of this document.

RESCISSION: H-08-8, dated June 1973; Revised March 1974, October 1978, May 1981, October 1986; H-18-8, dated December, 1995, Revised December 1997, and June 2000.

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1.0 DEFINITIONS

1.1 Ancillary Facilities: Buildings with functions that are not required for the emergency post-earthquake operation of VA hospitals. These facilities include, but are not limited to the occupancy categories listed as Ancillary Facilities in Table 3.

1.2 Critical/Essential Facilities: Buildings that are required to remain functional after an earthquake or other natural disaster such as a tornado or hurricane, etc. These facilities include, but are not limited to, the occupancy categories listed as Critical and Essential Facilities in Table 1 and Table 2, respectively.

1.3 FEMA 310: *Handbook for the Seismic Evaluation of Buildings - A Prestandard*, FEMA 310, Federal Emergency Management Agency, Washington, DC, January 1998.

1.4 FEMA 350: *Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings*, FEMA 350, Federal Emergency Management Agency, Washington, DC, June 2000.

1.5 FEMA 353: *Recommended Specifications and Quality Assurance Guidelines for Steel Moment-Frame Construction for Seismic Applications*, FEMA 353, Federal Emergency Management Agency, Washington, DC, June 2000

1.6 FEMA 356: *Prestandard for the Seismic Rehabilitation of Buildings*, FEMA 356, Federal Emergency Management Agency, Washington, DC, November 2000.

1.7 IBC: *International Building Code*. 2000 Edition, with issued supplements.

1.8 Seismicity

Region of Seismicity	S_S	S_1
Very High	> 1.250g	> 0.500g
High	< 1.250g > 0.750g	< 0.500g > 0.300g
Moderate – High	< 0.750g > 0.350g	< 0.300g > 0.140g
Moderate – Low	< 0.350g > 0.250g	< 0.140g > 0.100g
Low	< 0.250g	< 0.100g

Note: values for S_S and S_1 at all VA sites are given in Table 4.

1.9 Soft Story & Extreme Soft Story: As defined in IBC, (Table 1616.5.2).

1.10 Spectral Response Acceleration: A parameter used to characterize the anticipated earthquake shaking at a given site. (Table 4.)

Ss: The mapped spectral accelerations for short periods.
S_1: The mapped spectral accelerations for 1-second periods.

2.0 GENERAL

2.1 Critical & Essential Facilities (New & Existing)

All new facilities shall be designed and constructed, and existing facilities rehabilitated in full compliance with the earthquake design and detailing requirements of IBC as modified in these provisions. Critical and Essential Facilities shall be assigned to Seismic Use Group III (buildings and other structures that are intended to remain operational after an earthquake or other natural disasters such as tornado or hurricane, etc.) as defined in IBC section 1616.2.

2.2 Ancillary Facilities (New & Existing)

All new facilities shall be designed and constructed, and existing facilities rehabilitated in full compliance with the earthquake design and detailing requirements of IBC with no additional modifications. Ancillary Facilities shall be assigned to Seismic Use Group I as defined in IBC section 1616.2.

2.3 Existing Facilities - Evaluation

a. A seismic evaluation shall be conducted for existing facilities in areas of Moderate High, High, and Very High Seismicity that meet one or more of the following criteria:
   i. Facilities selected for renovation as part of a VA classified Major Project
   ii. Facilities selected for renovation where the area of renovation is greater than 50% of the total area
   iii. Facilities under consideration by the VA for purchase or lease

b. Existing Critical and Essential Facilities shall be evaluated using the procedures in FEMA 310 for the Immediate Occupancy Performance Level.

c. Existing Ancillary Facilities shall be evaluated using the procedures in FEMA 310 for the Life Safety Performance Level.

2.4 Existing Facilities Rehabilitation - Alternative Approach

a. An alternative approach may be permitted on case-by-case basis upon approval by Facilities Management for *Critical and Essential Facilities* to be strengthened according to the procedures in FEMA 356 to achieve the following rehabilitation objectives:

   i. Immediate Occupancy Performance Level at the BSE-1 (Basic Safety Earthquake Level-1; Earthquake Hazard Level having a probability of Exceedance of 10% in 50 years) as defined in FEMA 356.

ii Collapse Prevention Performance Level at the BSE-2 (Basic Safety Earthquake Level-2; Earthquake Hazard Level having a probability of Exceedance of 2% in 50 years) as defined in FEMA 356.

b. *Ancillary facilities* selected for seismic rehabilitation in compliance with FEMA 356 shall be strengthened using the requirements to achieve Basic Safety Objectives.

2. 5 Spectral Response Accelerations

The base shear in the design and analysis for all new and existing facilities shall be based on the spectral response accelerations shown in Table No. 4, which are obtained from the national earthquake hazard maps developed by the United States Geological Survey (USGS) for ground motions with a 2% chance of exceedance in 50 years.

2.6 Local Requirements

For projects where the local codes have more stringent requirements, the more stringent requirements shall be used.

3.0 MODIFICATIONS TO THE REQUIREMENTS OF IBC FOR NEW CRITICAL AND ESSENTIAL FACILITIES IN AREAS OF HIGH AND VERY HIGH SEISMICITY

3.1 Structural Irregularities (IBC 1616.5.2)

In areas of High and Very High Seismicity, the following types of irregularities as defined by IBC Table 1616.5.2 are not allowed:

a. Stiffness irregularity – Soft Story
b. Stiffness irregularity – Extreme Soft Story
c. Weight (mass) irregularity
d. Vertical geometric irregularity

3.2 Anchorage of concrete or masonry walls (IBC 1620.2.1)

The anchorage provisions of IBC section 1620.2.1 for buildings in areas of High and Very High Seismicity shall be modified as follows:

Maximum allowable diaphragm deflection normal to the surface of the wall elements under lateral force loading shall be limited as prescribed in Table 5 of these provisions.

3.3 Diaphragms (IBC 1620.3.3)

The diaphragm provisions of IBC section 1620.3.3 for buildings in areas of High and Very High Seismicity shall be modified as follows:
Maximum overall diaphragm dimension ratio shall be limited as prescribed in Table 6 of these provisions.

3.4 Seismic-force-resisting-systems (IBC, Table 1617.6)

The following structural systems are permitted for new facilities in all seismicities:

a. Building Frame Systems
    i. Steel eccentrically braced frames (EBF) moment resisting connections at columns away from links
    ii. Special reinforced concrete shear walls (Building Frame)
    iii. Special reinforced masonry shear walls (Building Frame)
    iv. Special steel concentrically braced frames
    v. Light frame walls with shear panels-wood structural panels/sheet steel panels (Building Frame) for structures two stories or less

b. Moment-resisting Frame Systems
    i. Special steel moment-resisting frames (SMRF), if approved
    ii. Special reinforced concrete moment-resisting frames

c. Dual Systems
   i. Special reinforced concrete shear walls with SMRF
   ii. Special reinforced masonry shear walls with SMRF
   iii. Steel EBF with SMRF
   iv. Special steel concentrically braced frame with SMRF

All other structural systems are not permitted unless written approval is obtained from the VA.

3.5 Special Provisions for Facilities in Areas of High and Very High Seismicity

In areas of High and Very High Seismicity the provisions of this section shall apply to all new Critical and Essential Facilities.

a. Bay spacing essentially shall be equal and uniform throughout.

b. Transfer beams or trusses supporting upper level columns shall not be used unless permitted on a case by case basis by the VA.

c. Seismic joints shall be avoided, in so far as possible. When required, they shall be specifically identified in the schematic design phase of the project and approved by VA, subject to the following provisions:

   1. Seismic joints shall be properly detailed on the working drawings.

   2. Seismic joints shall be sized based on the maximum expected displacements, considering the effects of story drift, diaphragm displacements and rotations, and a realistic approximation of element section properties. For materials designed considering the ultimate limit state, such as concrete, the stiffness representative of this state shall be used. Seismic separations shall be 125% of the separation required by IBC.

   3. Adjacent structures that are not integral with an existing structure shall be separated by not less than 2 inches per story.

3.6 Limitations on Reinforced Concrete Structures

In areas of High and Very High Seismicity the provisions of this section shall apply to all new Critical and Essential Facilities.

a. Prestressed concrete structural members, including pretensioned and post-tensioned members, and precast elements such as tilt-up wall panels, and precast beam and column elements shall not be used to resist seismic forces.

b. Lightweight concrete shall not be used in structural members resisting earthquake forces in High and Very High Seismicity, except in concrete floors and roof slabs used as diaphragm elements to distribute earthquake forces to vertical lateral-load resisting elements.

3.7 Limitations on Steel Structures

In areas of High and Very High Seismicity (ref. Table 4) the provisions of this section shall apply to all new Critical and Essential Facilities.

a. Special steel moment resisting frame systems (if approved) shall be subject to the following special provisions:

   1. The structural engineer of record shall review FEMA 350 and FEMA 353 and other current research and recommendations regarding steel moment resisting connections and shall adapt the findings to the design.

   2. During the schematic design phase of the project, the structural engineer of record shall submit to VA a clear statement of the criteria and design philosophy to be used in the design of the SMRF system and its connections, including the manner in which inelastic rotation will be considered.

   3. At the completion of the design development phase of the project, the structural engineer of record shall submit to VA a report describing the procedures that will be used for design, analysis, inspection, and welding of the frame joints, including any necessary specifications for laboratory and site testing of the connections.

   4. The construction/contract documents shall include a requirement for the Contractor to develop and submit a welding procedure specification (WPS) for each weld in accordance with Part II, Section 5 of FEMA 353. The WPS is subject to acceptance by VA. The WPS for each weld shall be kept at the job site and shall be available at the connection site during welding.

   5. All complete penetration welds shall be inspected by means of nondestructive testing (NDT) in accordance with Part II, Sections 3 and 5 of FEMA 353.

   6. Full time continuous welding inspection of preparation, welding, and post-welding procedures shall be required for all moment resisting connections in accordance with Part II, Sections 3 and 5 of FEMA 353.

b. Steel eccentrically braced systems shall be subject to the following special provisions.

   1. Connections of non-structural elements shall not be located in the vicinity of EBF link beams. Non-structural elements include, but are not limited to, precast panel connections, elevator guide rail supports, stairs, and pipe supports etc.

   2. Links shall not be located adjacent to columns unless the link-to-column connection design is based upon cyclic test results that demonstrate adequate inelastic rotation capability as required by IBC section 2212.

3.8 Story Drift Limitations

The calculated story drift for the construction of all new Critical and Essential Facilities shall not exceed 50% of the values allowed by IBC.

3.9 Exemptions

No action regarding seismic rehabilitation of existing buildings need be undertaken in moderate-low and low zones.

4.0 Elements of Structures, Nonstructural Components, and Equipment Supported by Structures for Critical and Essential Facilities

In areas of Moderate-High, High and Very High Seismicities, elements of structures and their attachments, permanent nonstructural components and their attachments, and the attachments of permanent equipment supported by a structure shall be designed to resist total design forces prescribed in IBC sections 1620 and 1621 as modified by this document.

Exceptions: Seismic restraint may be omitted for the following installations:

a. Gas and medical piping less than one inch inside diameter.

b. Piping in boiler and mechanical equipment rooms less than 1 ¼ inch inside diameter.

c. All other piping less than 2 ½ inch inside diameter except for automatic fire suppression systems.

d. All piping suspended by individual hangers, 12 inches or less in length from the top of pipe to the bottom of the support for the hanger.

e. All electrical conduits, less than 2 ½ inch inside diameter.

f. All rectangular air handling ducts less than six square feet in cross sectional area.

g. All round air handling ducts less than 28 inches in diameter.

h. All ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of the support for the hanger.

5.0 SITE DATA FOR CRITICAL AND ESSENTIAL FACILITIES

5.1 New and Existing Facilities

In areas of Moderate High, High, and Very High Seismicity, geologic hazards and site-specific ground-response reports shall be required for all proposed construction of new Critical and Essential Facilities and for all proposed seismic rehabilitation of existing Critical and Essential Facilities.

Unless Tables 1615.1.2(1) and 1615.1.2(2) of IBC require a site-specific ground-response report, the requirement for this report may be waived. The maximum considered earthquake spectral response accelerations shall be determined from the latest national earthquake hazard maps developed by the United States Geological Survey (USGS) for ground motions with a 2% chance of exceedance in 50 years, after adjustment for site class effects and deterministic limits specified in IBC.

5.2 Geologic Hazards Report

The purpose of the geologic hazards report shall be to identify potential geologic and seismic conditions that require detailed evaluation, and may require mitigation by the project. The report shall contain data that provide an assessment of the nature of the site and potential for earthquake damage based on preliminary investigations of the regional and site geology, subsurface conditions and the potential seismic shaking. The engineering geologic report shall not contain design criteria, but shall contain basic data to be used for a preliminary earthquake engineering evaluation of the project. The basis for seismic assessment in geologic hazards reports must be stated clearly.

The report shall include, but shall not be limited to the following:

a. Geologic investigation

b. Identification of any known active and potentially active faults, both regional and local, including estimates of the peak ground accelerations that could occur at the site.

c. Evaluation of any slope stability problems at or near the site, liquefaction potential and settlement potential of the building site.

VA shall approve the engineering geologic report prior to the preparation of the geotechnical report.

5.3 Site-Specific Ground-Response Report

The site-specific ground-response report shall present a detailed characterization of earthquake ground motions for the site. The characteristics of the expected strong ground motion to be used in design shall be determined by site evaluation studies based on geological and seismological characteristics of the site, including data given in the engineering geologic report. The estimates should be derived by accepted methods of seismological practice, and fully documented in the geologic hazards report. The level of ground motions to be developed shall represent an earthquake with a 2% chance of being exceeded in 50 years. The characterization of ground motion shall be given in terms of:

a. Peak acceleration, spectral response accelerations, bracketed duration, and predominant period.

b. Elastic structural response spectra with 5% damping for the expected ground motion at site classes C, D, and E.

c. A suite of at least 3 time-histories representative of the expected ground motion at the site for the design level earthquake.

6.0 COMMENTARY

Section 1.0

Section 1.2: Critical/Essential Facilities are those where most operations and functions must be able to resume immediately, while repair is required to restore some non-essential services due to a limited amount of seismic damage.

Section 2.0

Section 2.1: Previous editions of H-18-8 have defined, and had different seismic design requirements for, "Essential" and "Ancillary" buildings. Other documents such as FEMA 356 use somewhat similar definitions with the terms "Operational" and "Immediate Occupancy" performance for both building and nonstructural systems and elements.

Presently, the seismic design requirements of H-18-8 do not distinguish between the Critical and Essential categories. Since VA Medical Centers may be able to better withstand non-functioning buildings in the Essential category, opportunities may exist for the VA to exercise flexibility in meeting the requirements of H-18-8 for these buildings, such as using a phased or incremental strengthening approach. Additionally, it should be anticipated that the existing structure should have limited disruption, but that the building continues to remain occupiable and essentially operational after the earthquake.

Section 3.0

Section 3.3: The design engineer shall provide multiple lines of resistance when selecting a lateral force-resisting configuration. Redundancy of frame lines is intended to avoid concentration of seismic force demands in the structure and/or foundation system. Lines of lateral force resistance shall be located at major areas of plan irregularity such as reentrant corners, so that the aspect ratio of the resulting diaphragms is limited to as prescribed in Table 6.

Section 3.4: In order to obtain written approval for use of an alternate structural system, a complete cost estimate and an estimate of the probable maximum loss must be prepared for the alternate structural system and submitted to VA. Estimates for cost and probable maximum loss using an appropriate system that is listed in this section must be submitted for comparison. Approval will be granted only if the alternate system is cost effective and has the same or lower probable maximum loss.

Section 3.5.c: Because seismic joints have a serious impact on exterior siding, floor joints, and interior construction and utilities, they should be avoided if at all possible.

Section 4.0

There is no commentary for this section.

Section 5.0

Although site-specific studies exist for most of VA's Critical sites, the intent of this provision is to update those studies (done in mid-seventies) for all proposed construction of new Critical and Essential Facilities and all existing Critical and Essential Facilities selected for full seismic rehabilitation.

The standard practice of preparing a geotechnical report containing foundation recommendations, soil-bearing values, results of any necessary soil borings, etc. is still required for all VA projects.

Table 1: Critical Facilities*

Occupancy Subname
Acute Care
Ambulatory Care
Communications Center
Emergency Command Center
Emergency Generator
Fire/Police
Hazardous Material Storage
Information Systems (Equipment)
Long Term Care
Medical Gas Storage
Mental Health - Inpatient
Hospitals
Boiler Plants
Outpatient Clinics

Table 2: Essential Facilities*

Occupancy Subname
Animal Facilities
Dietetics
Domiciliaries
Drug/Alcohol Rehabilitation - I/P
Drug/Alcohol Rehabilitation - O/P
Medical Equipment Storage
Medical Records
Medical Research
Rehabilitation Medicine
Rehabilitation/Prosthetics
Psychiatric Care Facility
Security

* The Critical/Essential Tables were originally developed as part of the VA's ongoing seismic program as a means of assisting in the development of long range priorities. The seismic design requirements of H-18-8 do not distinguish between the two categories.

TABLE 3: Ancillary Facilities

Occupancy Subname	
Accessory Non-Building Structures	Maintenance Storage (Equipment)
Auditorium	Materials Management Storage
Biomedical Eng. (equip.& wheelchair repair)	Office
Canteen-Cafeteria	School
Canteen-Retail Store	Parking Garage
Cemetery Building	Plant Outbuildings
Chapel	Post Office
Child Care	Recreational
Clinical Service Administration Office	Student Housing
Connecting Corridors-Concourse, Bridges	Temporary Buildings
Credit Union	Toilets (Outhouses)
General Administration Offices	Training, Education
Greenhouses	Veterans Services
Quarters	Warehouse
Laundry	Waste Management
Library/Museum	(Incinerator & Recycle)
Maintenance Facility (Shops)	Waste Storage

Table 4
Spectral Response Accelerations at VA Facilities

Site	State	S_s	S_1	Seismicity
Abraham Lincoln	IL	0.212	0.077	L
Albany	NY	0.271	0.091	ML
Albuquerque	NM	0.620	0.185	MH
Alexandria	LA	0.141	0.070	L
Alexandria	VA	0.178	0.063	L
Allen Park	MI	0.125	0.046	L
Alton	IL	0.483	0.163	MH
Altoona	PA	0.165	0.060	L
Amarillo	TX	0.165	0.043	L
American Lake	WA	1.227	0.393	H
Anchorage	AK	1.499	0.558	VH
Ann Arbor	MI	0.124	0.047	L
Annapolis	MD	0.182	0.063	L
Asheville	NC	0.438	0.139	MH
Aspinwall	PA	0.128	0.057	L
Atlanta	GA	0.259	0.112	ML
Augusta	GA	0.422	0.151	MH
Augusta (Lenwood)	GA	0.422	0.151	MH
Balls Bluff	VA	0.179	0.063	L
Baltimore	MD	0.196	0.064	L
Baltimore/Loch Raven	MD	0.196	0.064	L
Barrancas	FL	0.101	0.055	L
Batavia	NY	0.318	0.075	ML
Bath	NY	0.184	0.064	L
Baton Rouge	LA	0.145	0.061	L
Battle Creek	MI	0.118	0.050	L
Bay Pines	FL	0.092	0.039	L
Beaufort	SC	0.645	0.209	MH
Beckley	WV	0.286	0.095	ML
Bedford	MA	0.335	0.091	ML
Beverly	NJ	0.335	0.083	ML
Big Spring	TX	0.114	0.033	L
Biloxi	MS	0.144	0.061	L
Birmingham	AL	0.315	0.115	ML
Black Hills	SD	0.142	0.041	L
Boise	ID	0.356	0.109	MH
Bonham	TX	0.171	0.071	L
Boston	MA	0.314	0.088	ML
Brockton	MA	0.287	0.084	ML
Bronx	NY	0.425	0.094	MH
Brooklyn	NY	0.416	0.092	MH
Buffalo	NY	0.323	0.070	ML
Butler	PA	0.127	0.055	L
Calverton	NY	0.248	0.074	L
Camp Butler	IL	0.257	0.117	ML
Camp Nelson	KY	0.240	0.104	ML
Canandaigua	NY	0.221	0.070	L
Castle Point	NY	0.342	0.090	ML
Cave Hill	KY	0.252	0.121	ML
Charleston	SC	1.482	0.421	VH
Chattanooga	TN	0.525	0.142	MH
Cheyenne	WY	0.185	0.056	L
Chicago (Lakeside)	IL	0.181	0.064	L
Chicago (Westside)	IL	0.186	0.064	L
Chillicothe	OH	0.179	0.077	L
Cincinnati	OH	0.186	0.088	L
City Point	VA	0.238	0.077	L
Clarksburg	WV	0.156	0.065	L
Cleveland/Brecksville	OH	0.215	0.058	L
Cleveland/Wade Park	OH	0.215	0.058	L

NOTE 1: No action regarding seismic rehabilitation of existing buildings need be undertaken in moderate-low and low zones.

Table 4, Continued
Spectral Response Accelerations at VA Facilities

Site	State	S_s	S_1	Seismicity
Coatesville	PA	0.327	0.081	ML
Cold Harbor	VA	0.270	0.079	ML
Columbia	MO	0.184	0.095	L
Columbia	SC	0.619	0.200	MH
Corinth	MS	0.428	0.183	MH
Crown Hill	IN	0.184	0.091	L
Culpeper	VA	0.227	0.075	L
Cypress Hills	NY	0.423	0.093	MH
Dallas	TX	0.118	0.058	L
Dallas/Fort Worth	TX	0.120	0.058	L
Danville	IL	0.228	0.101	ML
Danville	KY	0.225	0.109	ML
Danville	VA	0.223	0.095	L
Dayton	OH	0.246	0.082	L
Denver	CO	0.191	0.058	L
Des Moines	IA	0.073	0.042	L
Detroit	MI	0.125	0.046	L
Dublin	GA	0.235	0.108	ML
Durham	NC	0.210	0.099	L
Eagle Point	OR	0.626	0.304	H
East Orange	NJ	0.424	0.094	MH
El Paso	TX	0.369	0.112	MH
Erie	PA	0.163	0.053	L
Fargo	ND	0.073	0.019	L
Fayetteville	AR	0.185	0.095	L
Fayetteville	NC	0.287	0.129	ML
Finn's Point	NJ	0.273	0.072	ML
Florence	SC	0.850	0.263	H
Florida	FL	0.107	0.045	L
Fort Bayard	NM	0.287	0.085	ML
Fort Bliss	TX	0.369	0.112	MH
Fort Custer	MI	0.114	0.048	L
Fort Gibson	OK	0.183	0.084	L
Fort Harrison	MT	0.841	0.212	H
Fort Harrison	VA	0.282	0.082	ML
Fort Howard	MD	0.194	0.064	L
Fort Leavenworth	KS	0.126	0.057	L
Fort Logan	CO	0.211	0.060	L
Fort Lyon	CO	0.128	0.046	L
Fort McPherson	NE	0.088	0.032	L
Fort Meade	SD	0.189	0.051	L
Fort Mitchell	AL	0.160	0.084	L
Fort Richardson	AK	1.501	0.560	VH
Fort Rosecrans	CA	1.370	0.558	VH
Fort Sam Houston	TX	0.119	0.035	L
Fort Scott	KS	0.121	0.069	L
Fort Smith	AR	0.198	0.095	L
Fort Snelling	MN	0.057	0.027	L
Fort Thomas	OH	0.168	0.065	L
Fort Wayne	IN	0.163	0.063	L
Fresno	CA	0.449	0.202	MH
Gainesville	FL	0.118	0.059	L
Glendale	VA	0.282	0.082	ML
Golden Gate	CA	1.980	1.345	VH
Grafton	WV	0.159	0.065	L
Grand Island	NE	0.124	0.041	L
Grand Junction	CO	0.385	0.085	MH
Gulfport	MS	0.144	0.061	L
Hampton (VAMC)	VA	0.142	0.062	L
Hines	IL	0.191	0.063	L

NOTE 2: S_S and S_1 values have been obtained from the national earthquake hazard maps developed by the United States Geological Survey for ground motions with a 2% chance of exceedance in 50 years at a reference site condition of site class B. See Map pg 19.

Table 4, Continued
Spectral Response Accelerations at VA Facilities

Site	State	S_s	S_1	Seismicity
Honolulu	HI	0.600	0.170	MH
Hot Springs	SD	0.186	0.049	L
Houston	TX	0.105	0.043	L
Huntington	WV	0.218	0.088	L
Indianapolis (CS Rd)	IN	0.187	0.092	L
Indiantown Gap	PA	0.256	0.072	ML
Iowa City	IA	0.099	0.054	L
Iron Mountain	MI	0.063	0.026	L
Jackson	MS	0.189	0.095	L
Jefferson Barracks	MO	0.598	0.188	MH
Jefferson City	MO	0.211	0.106	ML
Kansas City	MO	0.121	0.060	L
Keokuk	IA	0.141	0.079	L
Kerrville	TX	0.079	0.026	L
Knoxville	IA	0.079	0.047	L
Knoxville	TN	0.579	0.146	MH
Lake City	FL	0.129	0.066	L
Las Vegas	NV	0.624	0.185	MH
Leavenworth	KS	0.126	0.057	L
Lebanon	KY	0.223	0.116	ML
Lebanon	PA	0.265	0.073	ML
Lexington	KY	0.250	0.101	ML
Lincoln	NE	0.177	0.049	L
Little Rock	AR	0.488	0.180	MH
Livermore	CA	1.500	0.600	VH
Loma Linda	CA	1.722	0.627	VH
Long Beach	CA	1.764	0.748	VH
Long Island	NY	0.371	0.087	MH
Los Angeles	CA	1.899	0.641	VH
Loudon Park	MD	0.196	0.064	L
Louisville	KY	0.249	0.119	ML
Lyons	NJ	0.410	0.093	MH
Madison	WI	0.112	0.044	L
Manchester	NH	0.405	0.103	MH
Marietta	GA	0.278	0.115	ML
Marion	IL	1.194	0.334	H
Marion	IN	0.155	0.073	L
Marlin	TX	0.103	0.048	L
Martinez/NCSC	CA	1.507	0.600	VH
Martinsburg	WV	0.194	0.065	L
Massachusetts	MA	0.265	0.075	ML
Mather	CA	0.425	0.197	MH
McClellan	CA	0.455	0.203	MH
Memphis	TN	1.335	0.404	VH
Menlo Park	CA	1.500	0.737	VH
Miami	FL	0.062	0.024	L
Miles City	MT	0.107	0.036	L
Mill Springs	KY	0.238	0.115	ML
Milwaukee (Wood)	WI	0.119	0.048	L
Minneapolis	MN	0.056	0.027	L
Mobile	AL	0.123	0.060	L
Montgomery	AL	0.169	0.084	L
Montrose	NY	0.388	0.092	MH
Mound City	IL	3.280	1.030	VH
Mountain Home	TN	0.165	0.080	L
Murfreesboro	TN	0.276	0.134	ML
Muskogee	OK	0.179	0.082	L
Nashville	TN	0.319	0.145	MH
Natchez	MS	0.151	0.078	L
New Albany	IN	0.249	0.119	ML

NOTE 1: No action regarding seismic rehabilitation of existing buildings need be undertaken in moderate-low and low zones.

Table 4, Continued
Spectral Response Accelerations at VA Facilities

Site	State	S_s	S_1	Seismicity
New Bern	NC	0.176	0.085	L
New Orleans	LA	0.130	0.057	L
New York	NY	0.423	0.093	MH
Newington	CT	0.276	0.085	ML
NMCA	AZ	0.286	0.085	ML
NMCP	HI	0.600	0.170	MH
North Chicago	IL	0.166	0.059	L
North Little Rock	AR	0.488	0.180	MH
Northampton	MA	0.255	0.087	ML
Northport	NY	0.348	0.086	ML
Oklahoma City	OK	0.346	0.086	ML
Omaha	NE	0.123	0.043	L
Orlando	FL	0.113	0.047	L
Palo Alto	CA	1.857	0.874	VH
Perry Point	MD	0.267	0.072	ML
Philadelphia	PA	0.338	0.084	ML
Phoenix	AZ	0.231	0.067	L
Pittsburgh	PA	0.128	0.058	L
Poplar Bluff	MO	1.140	0.320	H
Port Hudson	LA	0.144	0.064	L
Portland	OR	1.050	0.347	H
Prescott	AZ	0.496	0.135	MH
Providence	RI	0.268	0.080	ML
Puerto Rico	PR	1.000	0.400	H
Quantico	VA	0.184	0.065	L
Quincy	IL	0.173	0.090	L
Raleigh	NC	0.209	0.099	L
Reno	NV	1.352	0.487	VH
Richmond	VA	0.282	0.082	ML
Riverside	CA	1.500	0.600	VH
Rock Island	IL	0.129	0.062	L
Roseburg	OR	1.093	0.486	H
Saginaw	MI	0.080	0.037	L
Salem	VA	0.314	0.099	ML
Salisbury	NC	0.296	0.127	ML
Salt Lake City	UT	1.760	0.788	VH
San Antonio	TX	0.119	0.035	L
San Diego	CA	1.478	0.568	VH
San Francisco	CA	1.696	0.675	VH
San Joaquin Valley	CA	1.520	0.600	VH
San Juan	PR	1.000	0.400	H
Santa Fe	NM	0.603	0.188	MH
Saratoga	NY	0.300	0.095	ML
Seattle	WA	1.610	0.560	VH
Sepulveda	CA	1.712	0.735	VH
Seven Pines	VA	0.252	0.077	ML
Sheridan	WY	0.267	0.060	ML
Shreveport	LA	0.168	0.082	L
Sioux Falls	SD	0.113	0.036	L
Sitka	AK	0.810	0.456	H
Spokane	WA	0.320	0.092	ML
Springfield	MO	0.214	0.106	ML
St. Albans	NY	0.413	0.092	MH
St. Augustine	FL	0.127	0.064	L
St. Cloud	MN	0.074	0.019	L
St. Louis	MO	0.604	0.190	MH
Staunton	VA	0.238	0.083	L
Syracuse	NY	0.193	0.078	L
Tahoma	WA	1.251	0.413	VH
Tampa	FL	0.086	0.038	L

NOTE 2: S_S and S_1 values have been obtained from the national earthquake hazard maps developed by the United States Geological Survey for ground motions with a 2% chance of exceedance in 50 years at a reference site condition of site class B. See Map pg 19.

Table 4, Continued
Spectral Response Accelerations at VA Facilities

Site	State	S_s	S_1	Seismicity
Temple	TX	0.087	0.042	L
Togus	ME	0.325	0.096	ML
Tomah	WI	0.070	0.034	L
Topeka	KS	0.182	0.059	L
Tucson	AZ	0.330	0.088	ML
Tuscaloosa	AL	0.259	0.106	ML
Tuskegee	AL	0.166	0.084	L
Vancouver	WA	1.038	0.343	H
Waco	TX	0.093	0.046	L
Walla Walla	WA	0.469	0.137	MH
Washington, DC	DC	0.178	0.063	L
West Haven	CT	0.291	0.085	ML
West Los Angeles	CA	1.899	0.641	VH
West Palm Beach	FL	0.073	0.029	L
West Roxbury	MA	0.306	0.088	ML
West Virginia	WV	0.159	0.065	L
White City	OR	0.630	0.307	H
White River Junction	VT	0.341	0.107	ML
Wichita	KS	0.139	0.056	L
Wilkes-Barre	PA	0.236	0.075	L
Willamette	OR	1.026	0.323	H
Wilmington	DE	0.306	0.078	ML
Wilmington	NC	0.316	0.129	ML
Winchester	VA	0.193	0.068	L
Wood	WI	0.084	0.024	L
Woodlawn	NY	0.173	0.064	L
Zachary Taylor	KY	0.252	0.121	ML

NOTE 1: No action regarding seismic rehabilitation of existing buildings need be undertaken in moderate-low and low zones.

NOTE 2: S_s and S_1 values have been obtained from the national earthquake hazard maps developed by the United States Geological Survey for ground motions with a 2% chance of exceedance in 50 years at a reference site condition of site class B. See Map pg 19.

TABLE 5
MAXIMUM ALLOWABLE DIAPHRAGM DEFLECTION FOR ANCHORAGE OF WALL ELEMENTS

WALL ELEMENT	MAXIMUM ALLOWABLE DIAPHRAGM DEFLECTION[1]
Exterior walls – brittle construction	L/240
Exterior walls – ductile construction	L/180
Veneered walls, anchored veneers and adhered veneers over 1 inch thick, including the mortar backing	L/480

[1] L shall be taken as the span of the diaphragm to which the wall element is connected for resistance to out-of-plane loads

TABLE 6
MAXIMUM DIAPHRAGM DIMENSION RATIOS

	HORIZONTAL DIAPHRAGMS MAXIMUM SPAN-WIDTH RATIOS [1]		SHEAR WALLS
	Masonry and Concrete Walls	Wood and Light-steel Walls	MAXIMUM HEIGHT-WIDTH RATIOS
Concrete	3:1		
Steel deck (continuous sheet in single plane)	3:1	3:1	
Steel deck (without continuous sheet)	2:1	3:1	
Poured reinforced gypsum roofs, and interstitial floors	3:1	3:1	
Plywood (nailed all edges)	3:1	3:1	3-1/2:1 [2]
Plywood (nailed to supports only, blocking may be omitted between joists)	2-1/2:1 [3]	3:1	Footnote [5]
Diagonal sheathing (double)	Footnote [4]	3:1	1:1
Diagonal sheathing (single)	Footnote [5]	2:1	Footnote [5]

[1] Where lateral forces are resisted primarily by rotation, span-width ratios shall not exceed one half of the tabular values. In concrete or masonry buildings, wood diaphragms or diaphragms of similar flexibility shall not be permitted to resist lateral forces by rotation.

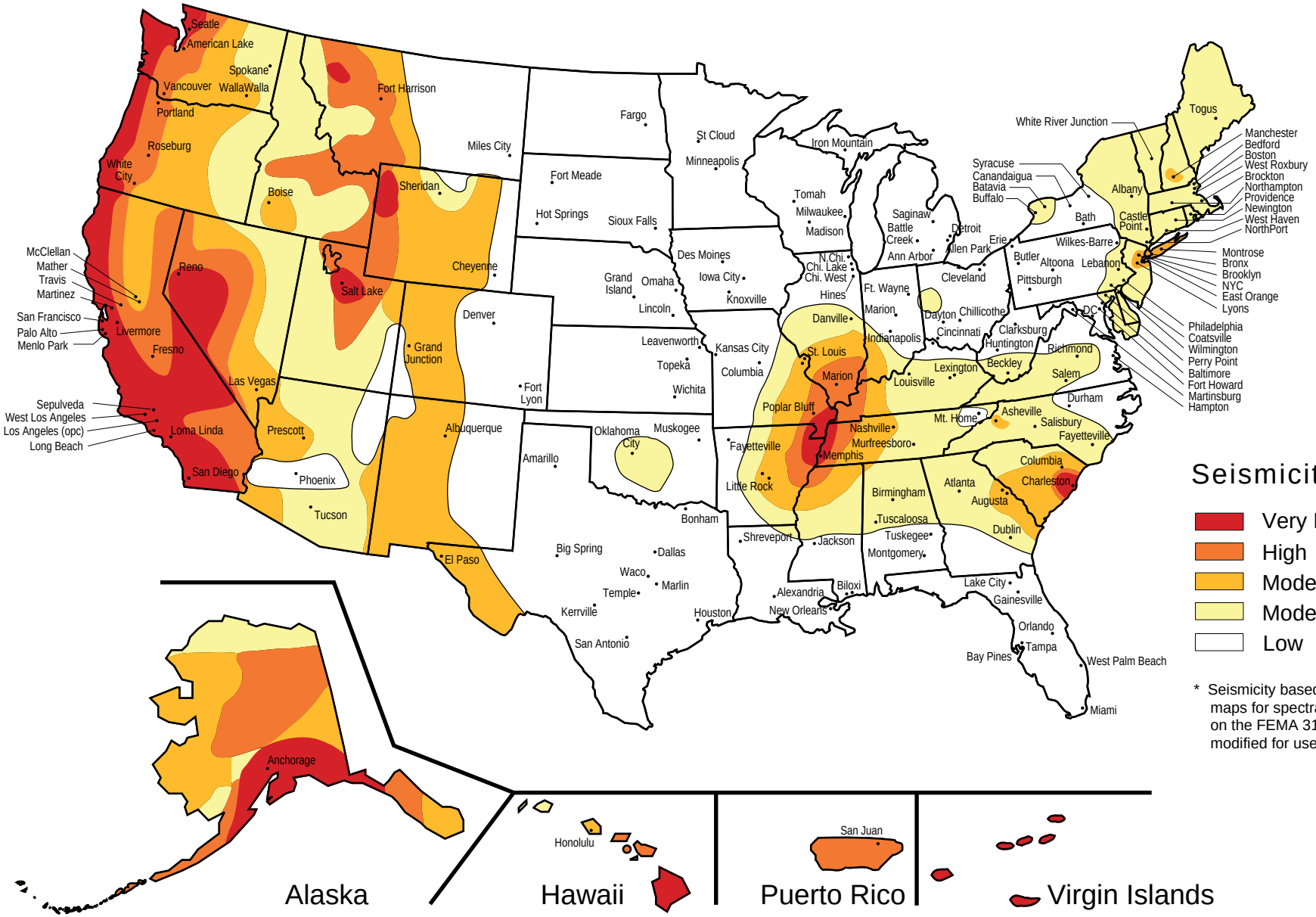
[2] See IBC section 2304.12 for use with masonry or concrete walls.

[3] The use of unblocked horizontal plywood diaphragms for buildings having masonry or reinforced concrete walls shall be limited to one-story buildings or to the roof of a top story.

[4] Not permitted.

[5] See IBC sections 2305.3.1 and 2306.4.

Seismicity Map with Department of Veterans Affairs Medical Centers



* Seismicity based on the 1997 USGS maps for spectral accelerations and on the FEMA 310 provisions, as modified for use by VA.